Replication in Mobile Environments

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What is the Problem?

Data replication among distributed databases occurring over disadvantaged (unreliable, low bandwidth or energy constrained) mobile wireless military communication networks

- extremely limited and highly variable **data throughput**
- **energy constraints**
- **inconsistent** databases

Different Ways of Solving the Problem

- Developing a solution in the described environment without considering existing solutions
- **here:**
  - Studying existing solutions
    journals, conferences, dissertations, ...
  - Check whether those solutions are applicable in our environment
- **Example:**
  - Dissertation David Howard Ratner:
    “Roam: A Scalable Replication System for Mobile and Distributed Computing”

Replication Models

- **Master - Slave**
  one replica: master, all others: slave
  slaves are read-only
  modifications are only performed with the master
- **Client - Server**
  functionality (modifications / updates) of clients improved
  multiple inter-communicating servers permitted
  no intercommunication between clients
- **Peer - to - Peer**
  all replicas are equal
  any replica can synchronise with any other replica

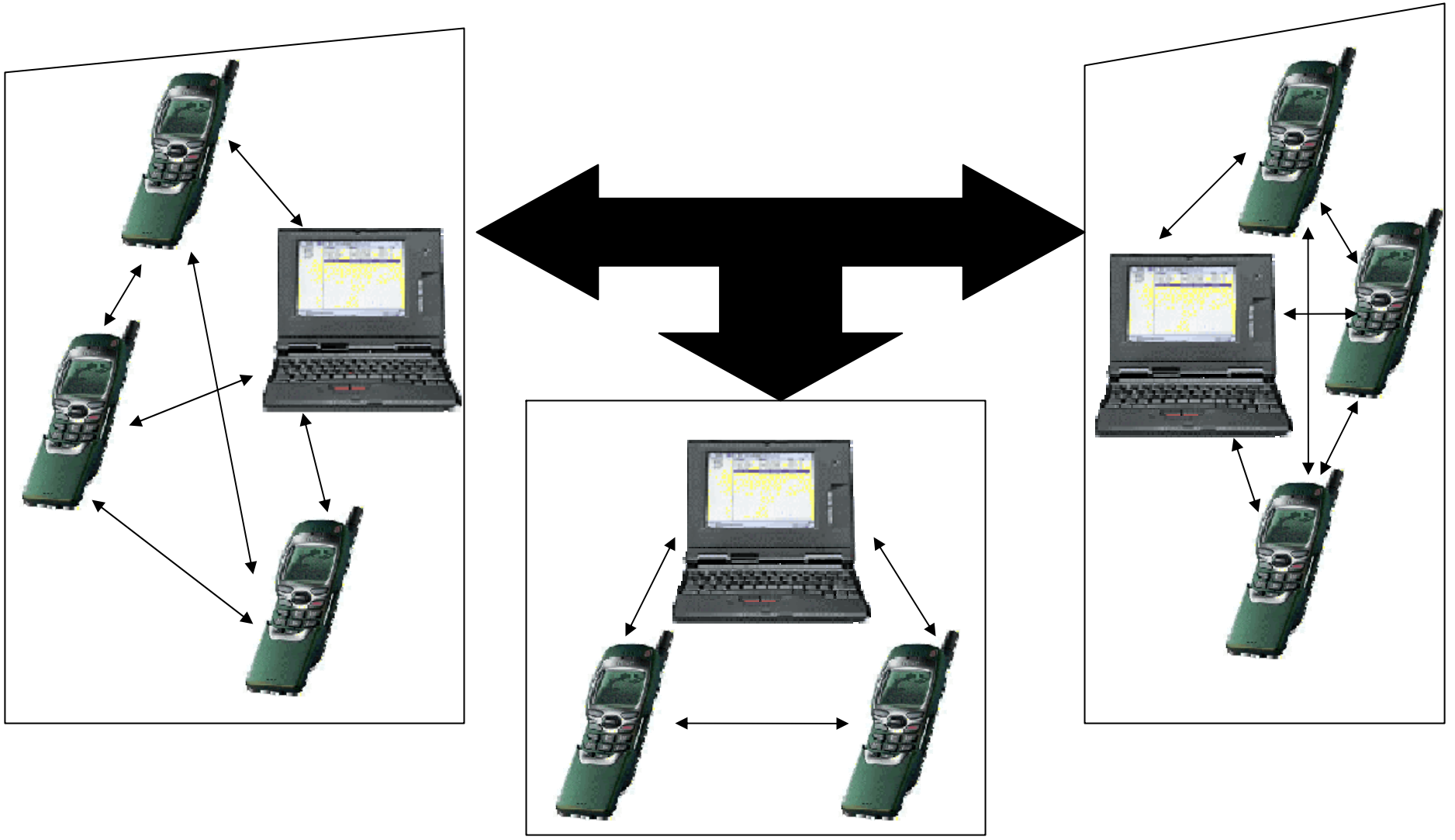
Problems of Replication Models

- **Master - Slave and Client - Server**
  no intercommunication between clients
  -> don't get replica from the nearest partner
  important position of server
  -> if server down, no update for clients
- **Peer - to - Peer**
  storing all necessary replication knowledge at every site
  -> exceedingly large data structures
  -> scaling problems

Ward Model [David Howard Rattner]

- **W**ide **A**rea **R**eplication **D**omains
- based on a hybrid between client-server and peer-to-peer
- one **ward master** representing the group
- Ward Grouping depends on:
  - Geographic location
  - Expected bandwidth
  - Connection latency
  - Expected network connectivity
  - Network cost
- All ward members are peers

Ward Example



Military Application

- Low-level units, like battalions or companies, that communicate via wireless communication systems, are modelled as a ward.
- Higher-level units, like brigades,... are modelled out of wards.

Consistency

Two approaches to achieve global **consistency**:

- **Conservative Approach**
  locking, voting, primary-site techniques to prevent conflicting updates
  not viable because of disconnection and partitions

- **Optimistic Approach**
  concurrent updates and conflicts are rare
  allows updates to be performed independently
  improving availability, but conflict resolution needed

Application in the Military Environments

- **Combination** of conservative and optimistic approach?
- Do we need **global consistency**?
- Is the described solution **applicable in military environments**?
- Are the advantages of **Broadcasting** integrated?
- Can **Selective Replication** be applied to reduce the number of replicated information?
  ATCCIS: replication by contracts